

WHAT IS CLAIMED IS:

- 1 1. A multilayered torsional hinged resonant pivoting device comprising:
  - 2 a hinge layer defining a support structure and an attaching member, said support structure
  - 3 for pivotally supporting said mirror attaching member along a first axis of rotation by a pair of
  - 4 torsional hinges, said attaching member having a front side and a back side, and said attaching
  - 5 member defining spines extending in opposite directions and away from said first axis;
  - 6 a front layer having a front portion, a back portion and a selected thickness, said back
  - 7 portion of said front layer mounted to said front side of said attaching member and said front
  - 8 layer having a known mass moment about said first axis; and
  - 9 a back layer mounted on said back side of said attaching member and having a mass
  - 10 moment substantially equal to and opposite said known mass moment of said front layer, such
  - 11 that the center of mass of the combined front and back layers is substantially coplanar with the
  - 12 first axis of rotation and the moment of inertia of said multilayered torsional hinged device is
  - 13 substantially centered on said first axis of rotation.
- 1 2. The multilayered device of claim 1 wherein said front portion of said front layer has a
- 2 first size and shape and said back portion of said front layer further defines spines corresponding
- 3 to said spines defined by said attaching member.
- 1 3. The multilayered device of claim 2 wherein said back layer further defines spines
- 2 corresponding to said spines defined by said attaching member.
- 1 4. The multilayered device of claim 1 wherein said back layer further defines spines
- 2 corresponding to said spines defined by said attaching member.

- 1 5. The multilayered device of claim 1 wherein said hinge layer comprises an anchor  
2 member connected to said attaching member along said first axis by said first pair of torsional  
3 hinges.
- 1 6. The multilayered device of claim 5 wherein said anchor member is a support frame.
- 1 7. The multilayered device of claim 5 wherein said anchor member is a pair of anchor pads.
- 1 8. The multilayered device of claim 1 wherein said support structure of said hinge layer  
2 comprises a gimbals portion connected to said attaching member along said first axis by said pair  
3 of torsional hinges and an anchor member pivotally supporting said gimbals portion by a second  
4 pair of torsional hinges along a second axis substantially orthogonal to said first axis.
- 1 9. The multilayered device of claim 3 wherein said support structure of said hinge layer  
2 comprises a gimbals portion connected to said attaching member along said first axis by said pair  
3 of torsional hinges and an anchor member pivotally supporting said gimbals portion by a second  
4 pair of torsional hinges along a second axis substantially orthogonal to said first axis.
- 1 10. The multilayered device of claim 8 wherein said anchor member is a support frame.
- 1 11. The multilayered device of claim 1 wherein said back layer is a permanent magnet.
- 1 12. The multilayered device of claim 2 wherein said back layer is a permanent magnet.
- 1 13. The multilayered device of claim 11 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency substantially equal to the resonant frequency of the  
3 pivoting device and wherein said magnetic coil and said permanent magnet interact to create  
4 pivotal movement of said device at said resonant frequency.

1 14. The multilayered device of claim 12 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency substantially equal to the resonant frequency of the  
3 pivoting device and wherein said magnetic coil and said permanent magnet interact to create  
4 pivotal movement of said device at said resonant frequency.

1 15. The multilayered device of claim 2 wherein said front portion of said front layer is a  
2 reflective surface and said multilayered device is a scanning mirror.

1 16. The multilayered device of claim 15 wherein said back layer further defines spines  
2 corresponding to said spines defined by said attaching member.

1 17. The multilayered device of claim 15 wherein said back layer is a permanent magnet.

1 18. The multilayered device of claim 17 wherein said support structure of said hinge layer  
2 comprises a gimbals portion connected to said attaching member along said first axis by said pair  
3 of torsional hinges and an anchor member pivotally supporting said gimbals portion by a second  
4 pair of torsional hinges along a second axis substantially orthogonal to said first axis.

1 19. The multilayered device of claim 18 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency equal to a selected sweep frequency of said scanning  
3 mirror and wherein said magnetic coil and said permanent magnet interact to create pivotal  
4 oscillations of said scanning mirror at said selected sweep frequency.

1 20. The multilayered device of claim 19 wherein said selected sweep frequency is  
2 substantially equal to the resonant pivoting frequency.

1 21. The multilayered device of claim 17 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency equal to a selected sweep frequency of said scanning  
3 mirror and wherein said magnetic coil and said permanent magnet interact to create pivotal  
4 oscillations of said scanning mirror at said selected sweep frequency.

1 22. The multilayered device of claim 21 wherein said selected sweep frequency is  
2 substantially equal, to the resonant pivoting frequency.

1 23. The multilayered device of claim 3 and further comprising piezoelectric material bonded  
2 to said support structure of said hinge layer to create resonant pivoting of said mirror.

1 24. The multilayered device of claim 1 wherein said hinge layer is made from single crystal  
2 silicon.

1 25. The multilayered device of claim 2 wherein said hinge layer is made from single crystal  
2 silicon.

1 26. The multilayered device of claim 3 wherein said hinge layer is made from single crystal  
2 silicon.

1 27. The multilayered device of claim 24 wherein said front layer is made from single crystal  
2 silicon.

1 28. The multilayered device of claim 25 wherein said front layer is made from single crystal  
2 silicon.

1 29. The multilayered device of claim 26 wherein said front layer is made from single crystal  
2 silicon.

1 30. The multilayered device of claim 17 and further comprising a magnetic coil connected to  
2 an alternating voltage having a frequency equal to a selected sweep frequency of said scanning  
3 mirror and wherein said magnetic coil and said permanent magnet interact to create pivotal  
4 oscillations of said scanning mirror at said selected sweep frequency.

1 31. The multilayered device of claim 30 wherein said selected sweep frequency is  
2 substantially equal to the resonant pivoting frequency.